Towards Understanding Confidence and Competency: Developing Bayesian Cognitive Models in an Academic Context

Executive Summary

In order to study the cognitive mechanisms relating to confidence and competency in academics, I distributed anonymous surveys to students in 6.004 and 6.034. Each group received two rounds of surveys prior to the final quiz in the class. The first round asked students to (1) report their class year and performance on previous quizzes, (2) assess their attendance, study habits, and campus involvement on a 5-point scale, and (3) predict their performance on the final quiz. The second round asked students to predict final quiz performance for other students based on first round responses. A final survey asked students to report their actual performance after the final quiz. A total of 13 students from 6.004 and 9 students from 6.034 completed the entire study.

I mapped numerical survey responses to Boolean values to simplify analysis. My first round of analysis determined maximum-likelihood conditional probabilities in a naive Bayes-inspired approach. Using this method, I found that students with good study habits (“studiers”) were much more likely to succeed versus “non-studiers” in 6.004 (P=4/5 compared to P=1/4), while the effect was reversed weakly in 6.034 (P=3/4 versus P=4/5). Additionally, students with good attendance (“attenders”) had much higher success rates than “non-attenders” in 6.004 (P=6/9 versus P=0), while this effect was again weakly reversed in 6.034 (P=5/7 versus P=1).

In both classes, peer-predicted success was correlated with both good study habits (P=3/5 for “studiers” versus P=3/8 for “non-studiers" in 6.004; P=1 for “studiers” versus P=3/5 for “non-studiers" in 6.034) and good attendance (P=5/9 for “attenders” versus P=1/4 for “non-attenders" in 6.004; P=6/7 for “attenders” versus P=1/2 for “non-attenders" in 6.034). In 6.034, self-predicted success was negatively correlated with both good study habits (P=1/2 for “studiers” versus P=4/5 for “non-studiers") and good attendance (P=4/7 for “attenders” versus P=1 for “non-attenders"). In 6.004, it was positively correlated with good study habits (P=2/5 for “studiers” versus P=1/8 for “non-studiers"), but slightly negatively correlated with good attendance (P=2/9 for “attenders” versus P=1/4 for “non-attenders").

In 6.004, students that predicted their own success (“confident”) had higher success rates (P=2/3 for “confident” versus P=4/10 for “not confident”), while students that peers thought would succeed (“admired”) were also more likely to succeed (P=4/6 for “admired” versus P=2/7 for “not admired”). However, in 6.034, being “confident” correlated less strongly with actual success (P=5/6 for “confident” versus P=2/3 for “not confident”), and peer-predicted success had a stronger correlation with actual success (P=6/7 for “admired” versus P=1/2 for “not admired”).

To more clearly answer research-related questions, I used Bayes nets and Metropolis-Hastings sampling to model and examine more complex causal relationships. I found that in 6.004, those most likely to succeed were either “confident and not admired” or “not confident and admired.” However, in 6.034, those most likely to succeed were “both confident and admired.” In general, 6.034 had a higher success rate (7/9 versus 6/13 for 6.004). My interpretation of these results is that students have a lower likelihood of success in 6.004, so the

ones that succeed generally need to make extraordinary efforts. This is enabled by both (1) having a need to excel due to some inadequacy, and (2) believing that effort will be worthwhile due to some encouraging factor. Thus, success rates are highest in 6.004 when a student is either "confident and not admired" or "not confident and admired." In contrast, in 6.034, success rates are higher, so competent students are generally able to settle into a routine, perform consistently well, and be confident. Thus, "confident and admired" students are most likely to succeed.

Furthermore, I found that upperclassmen not heavily involved on campus were most likely to be confident in 6.004, while underclassmen not heavily involved on campus were most likely to be confident in 6.034. This could be explained by the fact that heavy campus involvement leads to feelings of being overwhelmed, which decreases confidence. In addition, since 6.004 is a foundational class, upperclassmen tend to feel more experienced and capable of succeeding in it. Since 6.034 is a header, underclassmen that are in it tend to be academically ahead, so that they are likely to have more faith in their abilities.

Finally, I found that "studiers that are not confident" are much more likely to succeed than "non-studiers that are confident" in 6.004—out of 1000 random samples with balanced priors, about 33% represented the former and about 67% represented the latter. However, the effect was reversed for 6.034—using the same sampling approach, about 42% represented the former and about 58% represented the latter. This could be reflective of differences between the classes and the students.

Though the small sample sets imply that the data could be somewhat biased, my analyses reveal some insights regarding the cognitive workings behind confidence and competency. Further work could seek to increase sample sizes, build more complex models, and/or combine my approaches with other research endeavors at different levels of analysis.